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The importance of an oil resistance standard

Understanding Omron's innovative approach to protecting components from cutting oil

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Introduction

Cutting oil is a mainstay of many industries, and yet its presence can lead to the premature malfunction of essential components like proximity sensors. According to an internal Omron study completed in June 2016, approximately 30% of component failures are caused by cutting oil ingress. The traditional system for measuring the ruggedness of components only considers the impact of water and dust particles and fails to take into account the need for oil resistance as well. A new rating option – known as IP67G – is starting to gain traction as a way to document resistance to cutting oil and related substances.

This white paper will examine the impact of cutting oil ingress on components and present the benefits of investing in components made from oil-resistant materials.

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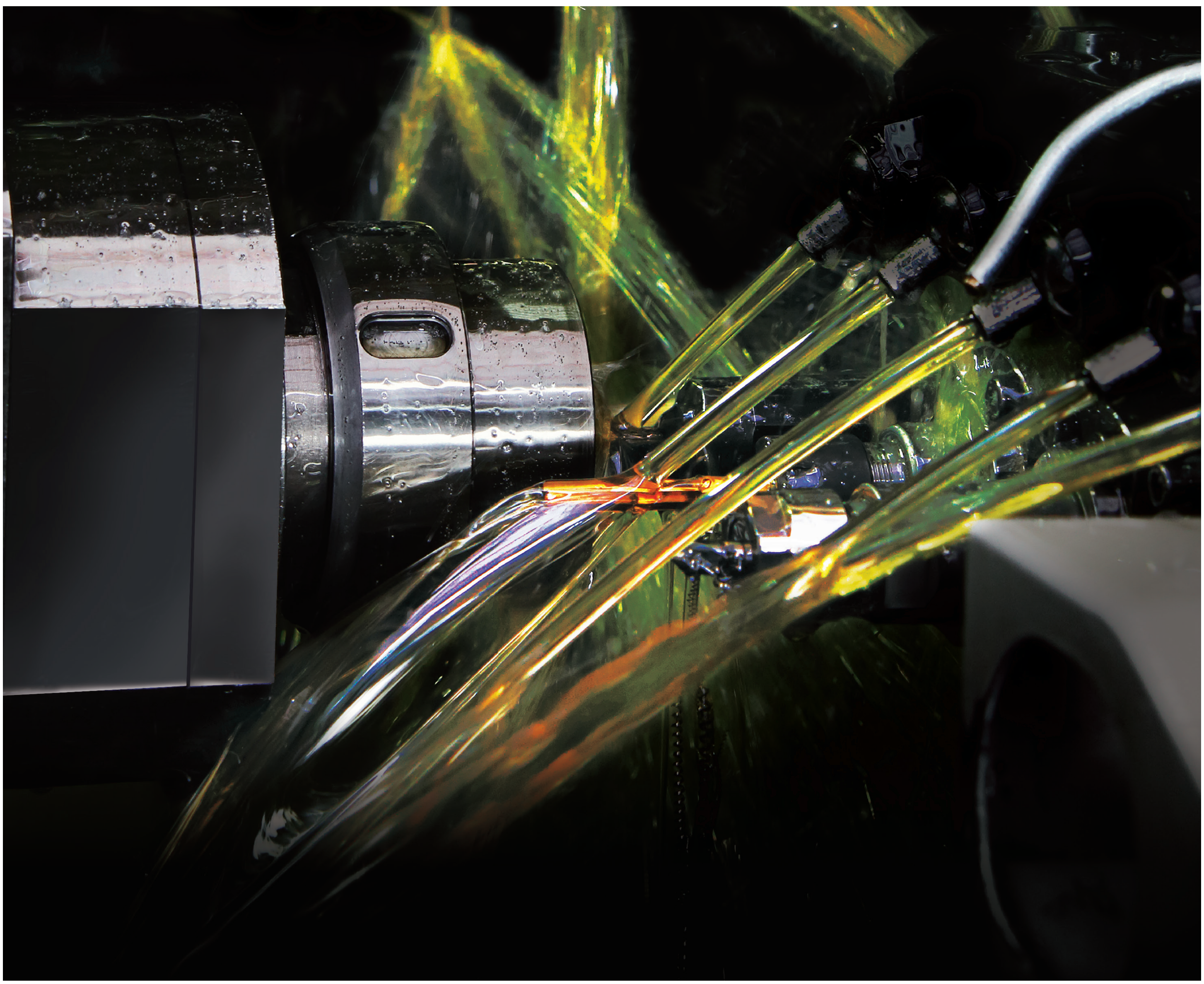
What is cutting oil used for?

Cutting oil performs many functions in applications that involve metalworking. These include lubricating the cutting process to decrease wear and tear on the tools, cooling the workpiece when high cutting speeds are used, and flushing away any chips or dust from the cutting area. By using cutting oil, manufacturers can benefit from longer tool life, reduced deformation of the workpiece due to heat, and improved chip handling.

Cutting oil is used with steel, particularly low-carbon steel, as well as with copper and aluminum. No cutting fluids are used with cast iron, since the graphite in the cast iron acts as its own lubricant and the fine powders that are produced can be a challenge to get rid of when they're mixed with oil.



Oil-Resistant IP67G Sensors provide rugged durability for harsh environments

How does cutting oil damage components?

The impact of cutting oil on proximity sensors and other components depends on the type of oil being used and the materials used to construct the components. According to the Japanese Industry Standard (JIS) rule, there are two types of cutting oils: soluble and insoluble. The soluble type, which includes emulsion and synthetic oils, is the most common thanks to its ability to reduce corrosion.

Water soluble and water insoluble oils can both penetrate cabling. Once they do so, they can run through the wire space and ultimately damage the printed wiring board (PWB) of the component itself. In addition to damaging the PWB, cutting oil also decreases insulated resistance. As cables are often made from polyurethane (PUR) or polyvinyl chloride (PVC), it's important to understand which type of oil is the most likely to adversely affect each type of material.

Soluble oils typically harm components by seeping into gaps around the cable. Any gap creates a potential for eventual damage. In particular, the alkali substances present in water soluble oils cause PUR cables to crack. This is because PUR has a tendency to absorb liquid, and once it absorbs the soluble oil, it becomes more susceptible to heat-related damage. PUR cables hold up much better when water insoluble oils are used.

PVC cables have the opposite problem – they become susceptible to breakdown when they come in contact with water insoluble oils. PVC contains a softener to keep it pliable, and insoluble oils can cause this softener to leach out of the cable. As a result, the cable becomes hardened and thins out. PUR cables don't use a softener, so there's no risk of them becoming hardened in the presence of non-soluble oils.

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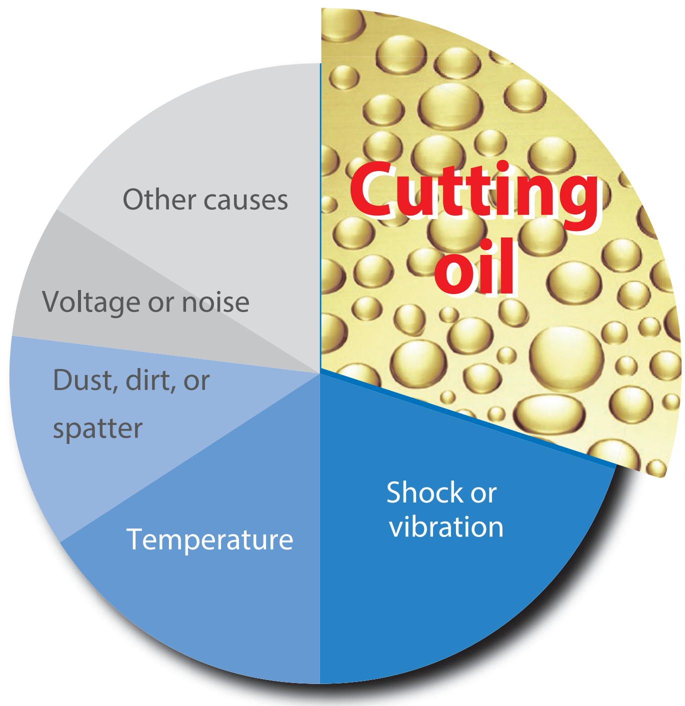

Omron's IP67G industrial rated sensors provide long life oil-resistant solutions

The case for a new IP rating

It’s clear that the presence of oil around cables and components has a significant negative impact on their longevity. Although it’s uncommon for IP ratings to include a reference to oil resistance in the United States, the JIS Committee has adapted the IP67 rating from the International Electrotechnical Commission (IEC) standard 60529 to indicate oil resistance when listed as “IP67G”. The G denotes protection against cutting oil ingress verified by a 48-hour oil immersion test.

Having a means to indicate oil resistance is an important first step, but it’s not necessarily good enough for real-world applications as is. IP67G is the only testing which can be seen in the industry to testify the degree of oil resistance. Unfortunately, 48 hours of testing isn’t long enough to properly replicate the demands of industrial situations that use cutting oil, and the oil used for IP67G validation is of the water insoluble type only. Customers now use soluble oils more frequently, and these consist of very tiny particles that can more easily seep into the gaps within sensing technologies.

In the absence of a comprehensive international standard for oil resistance, Omron goes well beyond the 48-hour oil immersion testing requirement when it validates its components’ ability to avoid damage from cutting oil. In the case of proximity sensors, for instance, Omron’s testing validates oil resistance for 1,000 hours of oil immersion. These tests are performed not only for the diluted solution used in regular IP67G tests, but also for undiluted cutting oils.

Standard oil-drop test

Omron extended life test

Strategies for achieving true oil resistance

If a manufacturing environment uses cutting oil, then it's of the greatest importance to ensure oil resistance for the types of devices that are most likely to come into contact with oil – or the devices for which long-lasting function is most critical, such as a those comprising part of the safety system. Manufacturers should consider choosing the oil-resistant versions of photoelectric sensors, proximity sensors, fiber sensor heads, cables, connectors, limit switches and safety light curtains.

Omron uses two main strategies for ensuring exceptionally high levels of oil resistance for its components. First of all, it strives to eliminate any gaps that could give the oil access to components' delicate interior workings. Omron's design uses special laser welding techniques on products with lenses – such as photoelectric sensors and light curtains – to create seals that are much more resilient than traditional lens adhesion methods. For cables and connectors, special molding seals and O-ring seals help keep oil out.

Omron's second strategy is to use special oil-resistant materials for components' cabling and protective sheaths. Since the deterioration of cable sheaths is a large factor in oil-related damage, Omron's IP67G-rated components are made from unique fluororesin materials to provide maximum protection. By providing superior resistance to corrosion, fluororesin helps suppress cable swelling and deterioration and prevents the ingress of cutting oil into the components' PCBs. The result is an oil resistance impregnable to even the most aggressive cutting oils.

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1. Strive to eliminate any gaps that could give the oil access to components' delicate interior workings.
2. Use special oil-resistant materials for components' cabling and protective sheaths.

Summary

Oil resistance has been traditionally overlooked as part of the IP rating system, but its impact on components can be severe where cutting oil is frequently used. For this reason, it's essential to have truly effective options for sensors, light curtains and other key technologies. In the absence of a truly comprehensive oil resistance rating system, Omron has striven to validate its components with rigorous testing that goes far beyond what's required for a basic IP67G rating.

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